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ABSTRACT

This publication presents the text of a speech on Canadian higher education's response to anticipated science and engineering personnel shortages. The talk opens by reviewing the statistics about current and anticipated labor force needs in sciences and engineering, data on students' study interests, and changes in the demographics of higher education enrollment, all of which indicate declining numbers entering science and engineering at a time of anticipated increase in the need for such personnel. The paper goes on to describe the dismay of science faculties at the quality of students, students' dislike of many colleges' teaching methods in the sciences, and difficulties with encouraging women to enter the sciences. In light of these difficulties, the paper notes some steps taken by universities and national associations including efforts to promote women in the sciences, efforts to stimulate high school students' interests in the sciences, programs to pair students with faculty, special seminars for high school teachers, programs that bring high school students to college campuses, and a lecture series on women in the sciences. (JB)

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Canada's Human Resources Problem
A many-faceted gem that's tough to crack

by

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Thank you for your kind introduction, Dale.

I want you to know how pleased I am to be a member of this morning's panel and to be able to share some thoughts with you about this country's human resources problem, particularly as it applies to the fields of science, technology, and engineering.

I'm not the type of person who gets a lot of pleasure out of just talking about problems. In fact, I'd be hard pressed to find anything pleasurable in the statistics that I'll be using to illustrate what we're up against as we set out to build a science culture in this country. But it seems to me that problems, by their very nature, provide us with opportunities--to stand back and take a fresh look at ourselves and our surroundings and to think about ways of doing things differently. Putting it another way, if it weren't for problems, one wonders whether there would be much human progress--technological, social or otherwise.

We're accustomed to dealing with problems at the university. And we're very much concerned with human progress. Unfortunately, university professors are often characterized as being somewhat detached from reality. They're off in their ivory towers (or so the story goes) studying the obscure, the arcane, and things of little consequence.

Well, that's not a very accurate picture of what goes on in the contemporary university. And it's certainly not an accurate picture of how universities are reacting to the problem we're discussing here today.

We're painfully aware of the fact that far too many of our young people are turning away from science and engineering. We know what this is doing to our science and engineering faculties and what it is likely to mean to this country if the trend continues. And we're realistic enough to know that Canada's human resources problem is a real gem--many-faceted and tough to crack. I'd like to spend the next few minutes putting that gem under **the university's** microscope and taking a closer look at what it means to us, how we think it came about in the first place, and what we're doing to reshape it.

Just about any way you slice it, the problem is massive and the prospects for this country's economic security, if current trends continue, are bleak.

John McDougall, who is president of the Canadian Council of Professional Engineers, said a couple of weeks ago that Canada will experience a shortfall of 60,000 engineers by the end of the decade. Mr. McDougall based that pronouncement on a study that was recently undertaken by the Canadian Engineering Manpower Board and the Canada Employment and Immigration Commission.

There are currently about 140,000 certified engineers in Canada, but only about 100,000 of them actually work as engineers. So why are we going to need all of these engineers all of a sudden?

Here's why. Employment opportunities in Canadian high technology companies are expected to increase by 3.5 per cent both this year and next. That's four times the rate for the economy as a whole. Last year, the sale of Canadian high technology products increased by 16.1 per cent, more than double the growth of this country's Gross Domestic Product. High technology exports grew by 11.6 per cent last year--compared to a paltry 1.4 per cent increase in Canada's overall export trade.

A recent survey of high technology companies undertaken by the Canadian Labor Market and Productivity Centre shows that more than half of the firms that were surveyed are already facing staffing problems. What's even more distressing, given this country's unemployment problems, is the fact that one out of every three companies in the survey said they would hire more staff today if they could find the qualified people.

Between 1978 and 1987, the number of scientists and engineers employed by Canadian industry increased by nearly 150 per cent. I don't need to tell you that science and technology are where it's at...and that doesn't just mean in the private sector either. Over the course of the next decade, one out of every five faculty members in Ontario will be facing retirement. You need scientists and engineers; we need scientists and engineers. So where are the scientists and engineers?

I can tell you this: they aren't at university.

In 1980, about 18 per cent of all full-time undergraduates in Ontario were studying engineering, applied science, mathematics or physical science. By 1987, that figure had dropped to 15.4 per cent.

Here are some more numbers that are just as depressing. In 1983 about one-third of all applicants to Ontario universities showed either math, science or engineering as their first choice of study. By 1988, just five years later, that figure had dropped to one out of every four.

And what about this latest crop of high school seniors? According to figures from the Council of Ontario Universities, 44 per cent of the students who applied to university from high school this year indicated the liberal arts as their first choice. Only 13 per cent chose science. I'd say we have the makings of a national disaster, especially when you go back a step further and take a look at what's happening to science enrolments in our high schools.

In the three years between 1985 and 1988, enrolments in advanced-level physics classes at Ontario high schools fell by 7,000--from nearly 26,000 students to 18,700. The decline was just as bad in biology. And in the case of chemistry, the story is even worse--here enrolments plummeted by nearly 10,000 or by about a third. With figures like these it's not surprising that a recent study by the International Association for the Evaluation of Educational Achievement found that, in their knowledge of chemistry, physics and biology, Canadian high school students performed near the bottom of the 13 countries in the survey. The only encouraging statistic that we can draw from that study is the fact that, up to Grade 9, Canadian students performed favorably when compared to those in other major industrialized countries. But somehow in high school we're losing them.

Why do we have this problem? Why are we getting so few students, particularly at the university level, who want to study science and engineering? One part of the answer is women. Not that they're part of the problem, but they are definitely part of what appears to be an all too elusive solution.

Women have accounted for the overwhelming majority of university enrolment increases over the last decade and more. But relatively few women have chosen to enter science programs and fewer still have enrolled in engineering. In 1975, just under six per cent of all full-time Canadian undergraduate students in engineering and applied sciences were women. By 1988, that figure had increased to 13.6 per cent. It more than doubled, but it can double again and women will still be grossly under-represented. In mathematics and the physical sciences the story is not much better. In 1975, women represented 27 per cent of full-time undergraduate enrolment. By 1988 that figure had crept ahead to just 29 per cent. The situation at my own institution is just as bad. While there has been a 300 per cent increase in the number of women enrolled in Carleton's engineering programs since 1975, today women still account for only 10 per cent of enrolment in engineering.

So, I'll repeat, why the problem? If there are opportunities in these fields, if there is a crying demand for more scientists and engineers in Canada, if universities are attracting more and more students (especially women), why aren't our young people looking to careers in these fields and preparing themselves for those careers in our schools and universities?

If it's any consolation, the problem is not exclusively Canadian by any means. Last Monday's edition of *The Wall Street Journal* carried an article on the very same crisis that's facing the United States. The *Journal* story offered several possible explanations for the malaise. University professors at various universities south of the border blamed their students. They said they were ill-prepared for the rigors of university science courses. According to the article, the professors complained about the students' short attention spans, their distaste for hard work, and their meager technical skills.

The university students, meanwhile, had few kind words for their professors. They accused them of having "antiquated teaching methods and draconian grading systems".

According to the article, at least a few scientists were willing to concede that some of the measures that university faculty members had come up with to "weed out" undesirable or somewhat less than serious students had probably outlived their usefulness. In the heyday of North American science culture, right after Sputnik in the late 1950s, would-be scientists were flocking to our universities. Bell-curve grading schemes and killer assignments were a natural way to divide the wheat from the chaff. Those days are well behind us now, and it's certainly high time for those members of our faculty who are still subscribing to that particular mindset to rethink their teaching and evaluation methods.

In a similar story that appeared in the *Toronto Star* back in July, reporter Lynne Ainsworth noted that Ontario high school teachers were complaining that the province's science curriculum left little time for hands-on learning opportunities. The curriculum's emphasis on text-book theories means high school instructors have few opportunities to look at the practical applications of science in everyday life. At the same time, the teachers were calling for elementary schools to hire more science specialists--to get the kids "hooked" on science, if you will, at an early age, when it counts.

And as for the special problem of promoting science and engineering to girls and women, I think Dr. Moyra McDill of Carleton's Engineering Faculty came pretty close to the mark when she had this to say at the Dialogue '90 Conference which brought high school guidance counsellors and university liaison officers together last spring in London. Said Dr. McDill:

My feeling is that the gender barrier is primarily a social issue. I know of parents who tell their daughters that girls can't do well in math and I know of little girls who believe it....On the whole we tend to shelter our daughters from technology. In order to choose a career in technology a child must be comfortable with technology. How many parents make the effort to show their daughters how to change a bicycle tire, use home power tools or even hammer a nail? These are the kinds of skills which foster confidence.

Furthermore, it should go without saying that misogynous behavior--that is so often associated with the rites of passage in our schools of engineering--does not inspire confidence. That kind of behavior has no place in our society, much less at our universities, and thankfully you're seeing university faculty, students, and administrations all across Canada finally taking a very tough stand against sexist behavior of any kind.

As a society, we have a long way to go toward promoting a science culture in this country. And if this is truly a **public** priority, it's difficult to rationalize government and private-sector spending patterns.

Why, for example, has the National Research Council's budget been slashed from \$480 million in 1984 to \$402 million this year?

Why has spending on research and development in Canada fallen from 1.43 per cent of Gross Domestic Product in 1986 to 1.28 per cent of GDP today--particularly when it's more than double that rate in Japan, the United States, and just about all of our European trading partners?

Why is it that Canada ranks 17th out of 20 industrialized countries in terms of private-sector spending on R&D according to a recent study undertaken by the World Economic Forum?

Why is it that, when our free-trade partner to the south is pouring \$450 million this year directly into science education--double what it spent last year--we have been unable (and perhaps unwilling) to find a way of allowing our own federal government to provide direct support for basic science education?

But even if we were to come up with reasonable answers to these questions, I don't know that we would be much closer to determining why so many of our young people are turning off science and engineering. Our society may not be doing a very good job of creating a climate that induces bright young minds to pursue careers in science, technology and engineering, but our failure in this regard only partly explains why few students are choosing to further their studies in these fields.

In order to answer that question, we need to bring in the social scientists to do some research. We know far too little about how students make their career and educational choices. If we're going to tackle this problem and do something about it without a lot of misdirected effort, we need some facts--certainly more than we seem to have at the moment.

In the meantime, what are the options?

Sitting on our hands is not one of them. And I think we can forget about importing the scientists and engineers that we can't seem to produce at home. That's worked before, but I doubt that it will work this time.

In the 1960s immigration supplied about half of all the new engineers in Canada. But by the mid-1980s, only one new Canadian engineer out of every 10 came from abroad. As I noted earlier, this particular human resource problem is shared by a lot of our competitors and you can bet that they'll be doing their best to keep their native talent at home and probably steal some of our as well.

So what can we do in the short term? What are we doing now?

Quite a lot, I'm pleased to say. And I'd like to cite some examples.

- The Canadian Committee on Women in Engineering, a consortium of professional, industry, education, and government organizations that was set up last April, is launching a \$1 million campaign to attract more women to the engineering profession. The group is also holding hearings across Canada to study some of the reasons why there are so few women engineers in this country and to promote public awareness of the problem.
- The Natural Sciences and Engineering Research Council of Canada has a new program of undergraduate research awards aimed specifically at women in their second year of science and engineering at university. Also, NSERC hopes to introduce a new research award aimed specifically at women faculty members.

- The Corporate-Higher Education Forum is setting out to find more effective ways to interest students in science and technology. One of its goals is to foster initiatives to attract and retain good teachers, especially in math, science, and technology.
- The University of New Brunswick, Northern Telecom, and NSERC have established Canada's first-ever chair of Women in Engineering at UNB in Fredericton. Dr. Monique Frize, who is the first woman to hold the chair, is looking into why so few women choose engineering as a career. She's also leading a cross-Canada campaign to promote the profession to women. In fact, Dr. Frize will be speaking at Carleton later this year as part of a substantial lecture series on *Women in Science and Technology* that's being sponsored by Carleton's Institute of Women's Studies and the university's Office for the Status of Women.
- A couple of hours' drive northwest of here is the Deep River Science Academy. This is the brainchild of a couple of senior researchers at Atomic Energy of Canada Limited. Each year it brings together a group of high school students from across Canada to work, first-hand, with scientist/mentors.

- Next month about 5,000 Grade 9 students from the Ottawa area will be taking part in a four-day program designed to give them a taste of what it's like to work and study in the high technology, engineering, and scientific fields. *Destiny 2000* is the creation of Hugh MacDiarmid, president of Lumonics. The program is being supported by the Ottawa-Carleton Research Institute and the Ottawa-Carleton Learning Foundation. Some 23 area high-tech firms and local educational institutions, including Carleton, will have displays at the event.
- The Ottawa-Carleton Research Institute and the Ottawa-Carleton Learning Foundation are also partners in a summer institute for teachers of mathematics, science, computer science, and technology. The institute helps to familiarize local teachers with some of the research and development projects that are being undertaken by members of the academic and industrial communities in the metro-Ottawa area.

And at my own institution, we aren't exactly standing still either.

- Last April, Carleton signed a Partners in Education agreement with Glebe Collegiate here in Ottawa. Under that agreement, we'll be hosting a conference on non-traditional careers for Grade 10 students at Glebe in March. We're also planning a series of professional development days for Glebe teachers where they'll be brought to campus to get a first-hand look at what goes on in our labs and classrooms.

Under that same agreement, we'll be looking to establish a twinning program for teachers and professors. That kind of program is especially important for an institution like Carleton that has no Education school. We're convinced that our faculty members would do a better job if they had a clearer idea of what's going on in the schools, and vice-versa for the high school teachers. In the near future we expect to enter into a similar agreement with Brookfield High School, which is also here in Ottawa.

- This year for the first time, Carleton's Faculty of Engineering is inviting about 300 local high school students on campus to get a feel for engineering studies at the university. The secondary students will be paired with student mentors who are already in some of our undergraduate or graduate programs.
- And about 60 undergraduate and graduate women students at Carleton are taking part in a program that's organized by the Ontario Women's Directorate in which our students visit with Grade 9 girls to talk about their career and study options.

Canada's universities aren't exactly asleep at the wheel on this one. But we have a long way to go to get where we're going and, as I suggested earlier, we will need to know a lot more about what's involved in student decision making than we know now.

As time goes on, I think it will become increasingly clear that our hopes for a science culture in Canada are going to rest on some fairly fundamental societal values. We may be looking at nothing short of a re-orientation of our national psyche, a cultural transformation.

That's a pretty tall order. But I'm confident that we have the technology to make it happen and that it's beginning to happen now. What is needed is a broadly-based, deeply set process of popularization, something like what has happened with interest in the environment over the past decade. In fact, that interest may provide us with one of our most promising "handles" to make science and technology attractive for young people. New programs in both environmental science and environmental engineering now being introduced at Carleton, and at several other universities across the country, might help to stimulate renewed interest in these fields among our youth.

But we educators cannot do it alone. People like you--who make their living as scientists, engineers, and technologists--have a very important role to play too. Essentially, you've got to find some way to convince kids across Canada that you're having fun.

So smile, and let's go get 'em together.